TECHNICAL NOTES:

COMPARISON OF THREE METHODS OF RESIDUE COVER MEASUREMENTS ON RAINFALL SIMULATOR SITES

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ABSTRACT. *Video image analysis, drop pins, and dot-screen methods were used to measure wheat residue cover in 1-m² rainfall simulator boxes under undisturbed field conditions. The data set consisted of 53 sites on a set of field plots which represented residue cover on chisel-till and no-till systems two months after wheat harvest. If the mean from the three methods is taken as the true cover, then there was a trend to produce 5% cover above average cover values with the pin method and 1% cover and 4% cover below average values with the dot and video methods, respectively. For no-till conditions of cover in the 80 to 100% cover range, the differences in values achieved with the three methods may be of little consequence, because the soil is adequately protected. For the low-residue cover chisel-till conditions, the differences were as much as 50% of the mean cover and could produce misleading information on the effect of residue cover on runoff, erosion, water quality, and other products of rainfall simulator studies.* **Keywords.** *Video images, Drop pins, Dot-screen.*

Residue cover of cropland soils has been identified as a positive agent for the reduction of wind and water erosion, improvement of runoff water quality, improvement of infiltration, and associated benefits. For example, a specified level of residue cover after planting is part of many farmers' conservation plans for compliance with federal programs for highly erodible lands. Rainfall simulation is the process of applying artificial precipitation to a small area in a highly controlled manner for the detailed measurement of effects of the rain. Quantification of the proportion of soil surface which is covered with residues, when done in conjunction with rainfall simulation studies, require that the sites can not be disturbed. Therefore, measurement alternatives are limited to nondestructive methods. Three such methods for detailed research are: 1) one variation of the line transect, such as the drop-pin method (Hawkins and Cross, 1982), 2) the projection of photographic slides onto dot-screens (Morrison et al., 1989), and 3) video image analysis (VIA) (Han and Hayes, 1990; Morrison and Chichester, 1991). A rainfall simulation study (Potter et al., 1995) presented the opportunity to compare these three methods under controlled conditions.

A principal difference between measurement methods is the characteristic number of observations taken with each. Morrison et al. (1989) showed that as the number of observation points increased for the dot-screen method, the value for mean cover changed, often decreasing to a stable value. If this is true for all three measurement methods, then the results should reflect the number of observations.

The objective of comparing these three methods for detailed residue cover measurement was to establish the typical spread of data values and similarities or differences in cover values among the methods. The results should be of interest to those who use functional relationships between residue cover and rainfall effects in prediction models.

METHODS

Rainfall simulator studies were conducted on tillage plot study areas at Temple, Texas (Potter et al., 1995). The plots were long-term rotations of wheat (*Triticum aestivum* L.), grain sorghum [Sorghum bicolor (L.) Moench], and corn (*Zea mays* L.) under chisel-till and no-till systems. The rainfall simulation studies were conducted two months after wheat harvest. Chisel-till plots had been shredded close to the surface, chisel plowed 15 cm deep, tandem disked, field cultivated, and reformed into a raised wide bed field surface configuration. No-till plots were configured in permanent raised wide beds (Morrison et al., 1990) and undisturbed since harvest. Simulator studies were conducted by positioning a 1-m² steel barrier box on each of 53 selected sites on the relatively flat bed surfaces. Residue cover measurements were made within these steel barriers before, at the middle break, and after rainfall simulations. The two tillage treatments were used to produce a wide range of residue cover, but were not considered to be factors in the comparison among measurement methods.

The drop-pin measurement method consisted of placing a bar diagonally across the steel barrier. The bar had 50 stratified, randomly spaced holes for a 2-mm-diameter rod "pin" to freely fall downward to touch the surface. The pin was sequentially dropped through the 50 holes with counts of "hits" on pieces of residue recorded. The bar was then switched to the opposite diagonal position and the

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counting continued for a total of 100 points observed. The apparatus was shop-built with $5.00 worth of materials.

The dot-screen measurement method consisted of taking a 35-mm color slide photograph from an overhead position. Each slide was projected onto three different screens with 300, 3-mm-diameter dots, each in random positions as recommended by Morrison et al. (1989). "Hits" of residue on dots were counted. The mean of 900 observation points from the three screens was used as the characteristic value for this method. Cost of the camera, projector, and supplies was approximately $1000.00.

The video measurement method consisted of taking a still video image from the same overhead position used for each photographic slide. Images were taken and processed with equipment as described by Morrison and Chichester (1991), with establishment of the soil background color separately for each image and automated analysis of 12% of the image pixels, or approximately 25,000 randomly selected points. Cost of the VIA apparatus was more than $20,000.00.

Results from 53 rainfall simulation sites were analyzed to compare the three methods for measuring residue cover. Deviation of each measurement from the mean of the three methods was calculated for each site. SAS (SAS Institute Inc., Cary, N.C.) statistical procedures were used to establish the main effects and correlations.

Results

As is common in the field measurement of residue cover, the true value for cover was not known. Therefore, the following results are a comparison of the precision, but not the accuracy from use of three measurement methods. Correlations among residue cover values from the three methods were 0.95 or better for the full data set (table 1). This would, in general, indicate that results from the three methods would be indistinguishable, but that analysis could be misleading. If the data below 50% cover is separated from the full data set, the correlation coefficients between methods range from 0.27 to 0.42 (table 1), without a significant correlation between dot-screens and video imaging.

If the mean of the three methods is taken as the true cover on each site, then the deviation from that mean is a statistic for the comparison of methods. The mean deviation for the drop-pins was about 5% cover above the site mean for the full data set (table 2). The mean deviation for dot-screens was 1% cover below the mean, while the video method produced a mean deviation about 4% cover below the site cover. For data below 50% cover, the differences between methods are not changed in ranking and only tend to be larger than for the full data set.

Table 1. Correlation coefficients among three residue cover measurements

	Correlation with Method (Probability)		
Method	Drop-pins	Dot-screen	Video Imaging
Full Data Set			
Drop-pins	1.0 (0)	0.96 (0.0001)	0.97 (0.0001)
Dot-screens	0.96 (0.0001)	1.0 (0)	0.95 (0.0001)
Video imaging	0.97 (0.0001)	0.95 (0.0001)	1.0 (0)
< 50% Cover Data			
Drop-pins	1.0 (0)	0.42 (0.02)	0.34 (0.07)
Dot-screens	0.42 (0.02)	1.0 (0)	0.27 (0.16)
Video imaging	0.34 (0.07)	0.27 (0.16)	1.0 (0)

Table 2. Deviation of residue cover measured values from the mean at 53 rainfall simulation sites

	Mean Deviation From Site Mean	
	Full Data Set	< 50% Cover
Method	(%-Cover)	
Drop-pins	5.22a*	6.75a
Dot-screens	–0.97b	–0.93b
Video imaging	–4.25c	–5.82c

* Different letters in a column indicate means which are different at the 5% level of significance for a LSD of 2.22 and 1.99, respectively.

Data points and regression lines for the full data set in figure 1 illustrate that this separation among methods was consistent for the study. The regressions were statistically different at the 5% level or better, as compared by an F-test on standard error between pairs of regressions.

The trend toward lower values for cover with an increasing number of observation points from 100 to 25,000 for the three methods may be more indicative of the "precision" obtained with increased numbers of observations, than with the "accuracy" of every observation within each method. The trend is consistent with previously published results (Morrison et al., 1989) and suggests that wheat residue cover will be over-estimated by use of only 100 or several hundred point "hit-or-miss" observations.

Conclusions

Separation of residue cover values among measurement methods for the no-till conditions of cover in the 80 to 100% cover range may be of little practical interest because the soil is sufficiently protected from sediment losses (Potter et al., 1995). Conversely, when the soil cover was in the 15 to 50% cover range, the sometimes wide spread of values for cover among the three well-established methods tested in this study could lead to misunderstandings of the functional relationships between residue cover and rainfall-caused dynamics. This may be particularly important for very detailed rainfall simulator studies, when the results are used to support erosion and water quality models. For those

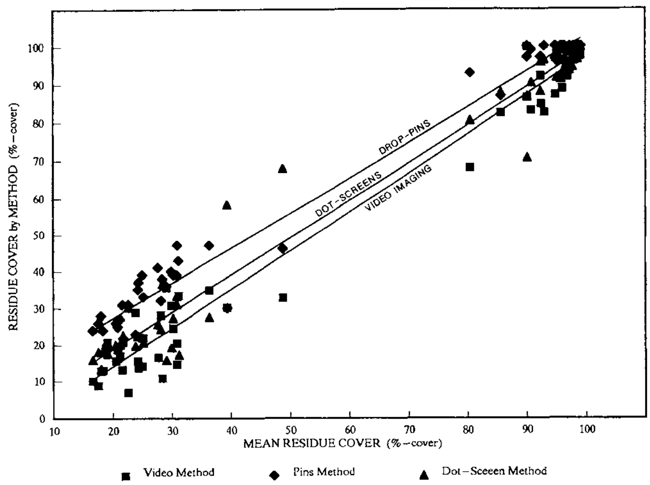

Figure 1–Wheat residue cover values for three measurement methods compared with the mean residue cover for the three methods, as tested on 1-m² rainfall simulator sites.

cases, the higher number of observation points in the VIA method should produce a more reliable result, but at a higher cost of apparatus.

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